



United States Patent [19] Patent Number: 6,005,835
Tsuji et al. [45] Date of Patent: Dec. 21, 1999

U.S. Patent Dec. 21, 1999 Sheet 1 of 15 6,005,835

- [54] COMPOSITE PRISM AND OPTICAL PICKUP
USING THE SAME
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- [32] U.S. Cl. 369/112, 369/103, 369/109
- [58] Field of Search 369/110, 112, 44, 23, 44, 24, 103
- [56] References Cited
- FOREIGN PATENT DOCUMENTS
0 612 068 A2 8/1994 European Pat. Off.
- 0 612 068 A3 8/1994 European Pat. Off.
8,329,544 12/1996 Japan
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- [57] ABSTRACT
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Attorney, Agent, or Firm—Pacthner & Wiedel, L.L.P.
- A prism and an optical pickup employing such prism includes a parallel prism having a polarization beam splitter film and a reflection film. The polarization beam splitter film is formed on an angled plane of a glass material having an approximate parallelogram cross-section, and consists of a multi-layer film of a composite film made of Si and SiO₂ (x<0.5) and multiple layers of multiple dielectric films. The reflection film is formed on an angled plane of the same glass material approximately parallel to the angled plane on which the polarization beam splitter film is formed, and consists of a multi-layer film of a composite film made of metal Si and oxide SiO₂ (x<0.5) as a high refractive film and multiple layers of multiple dielectric films as a relatively low refractive film.

23 Claims, 15 Drawing Sheets

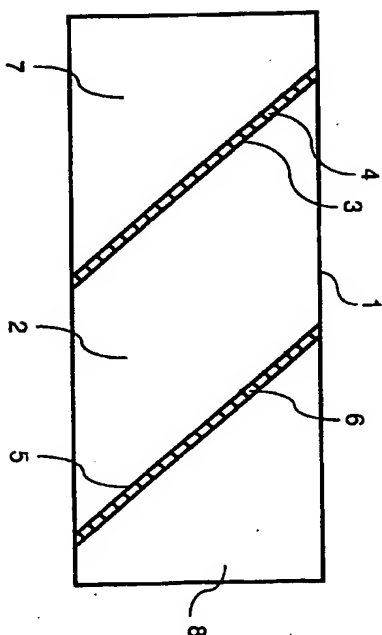
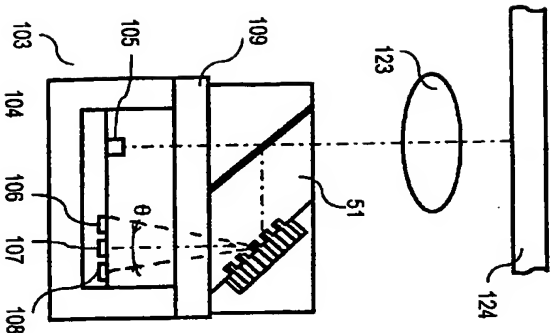


FIG. 1

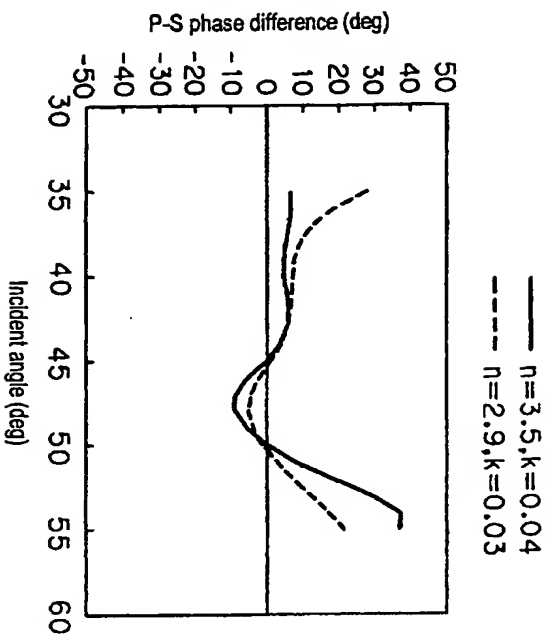


FIG. 2

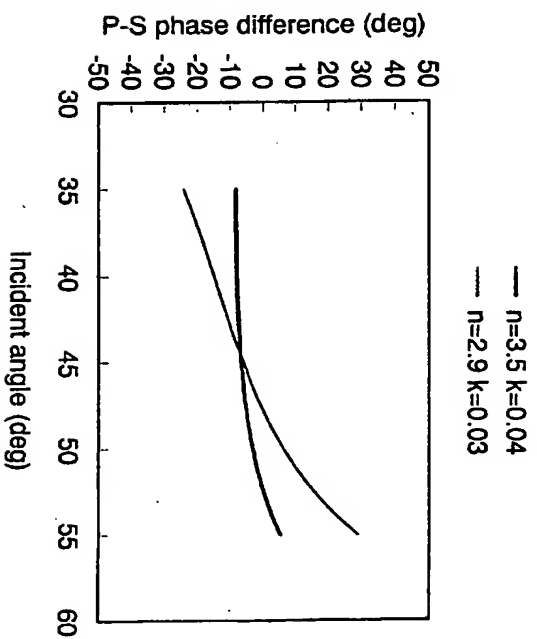


FIG. 3

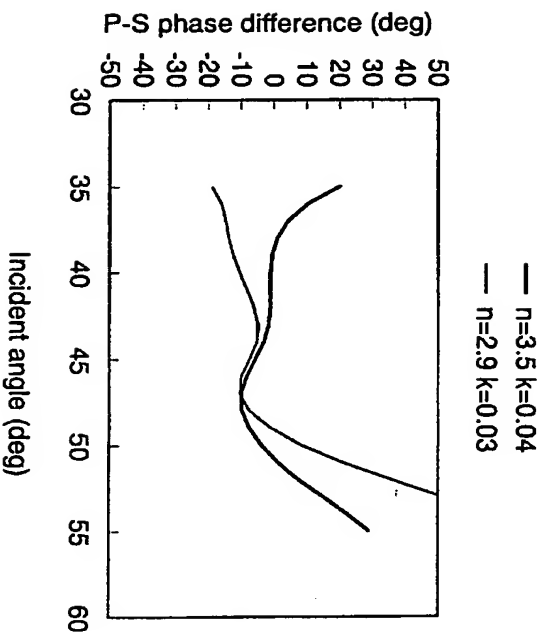


FIG. 4

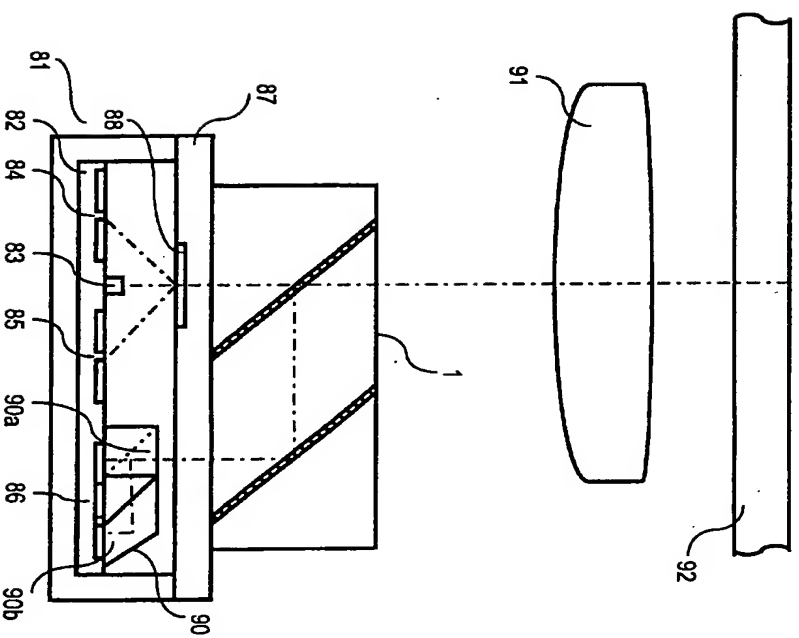


FIG. 5

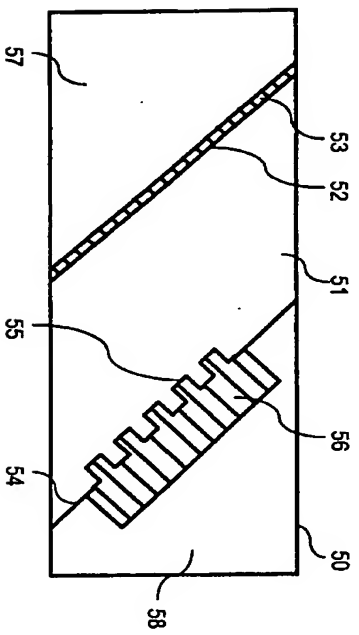


FIG. 6

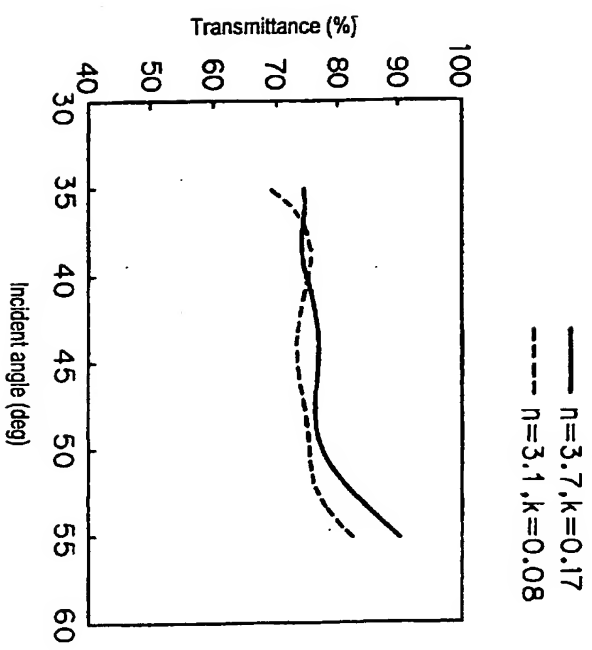


FIG. 7

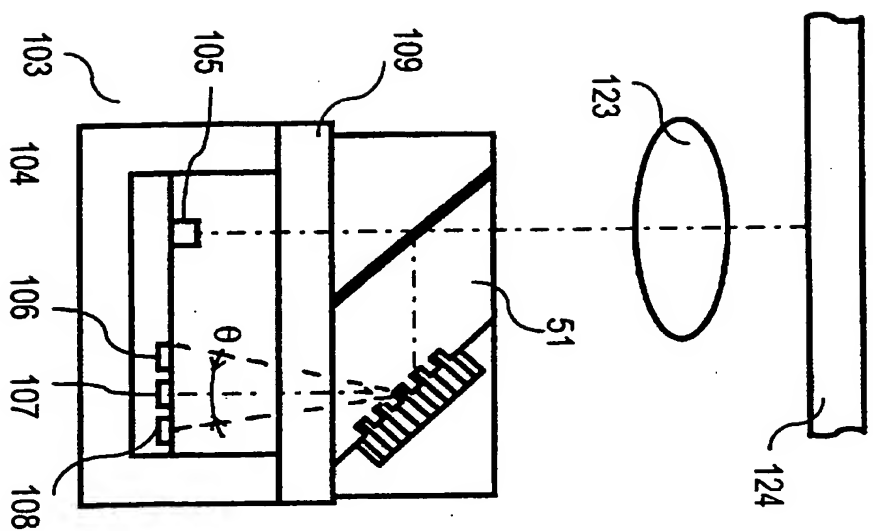


FIG. 8

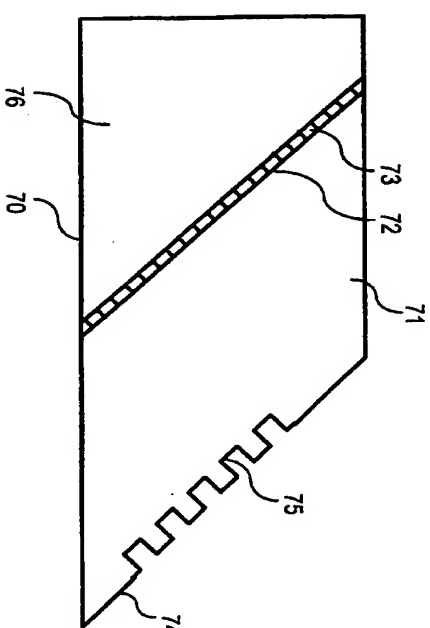


FIG. 9

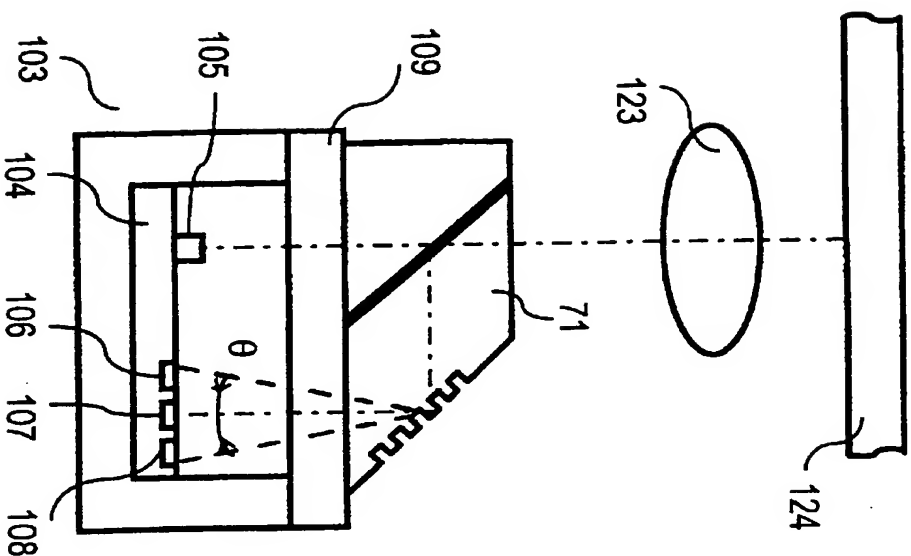


FIG. 10

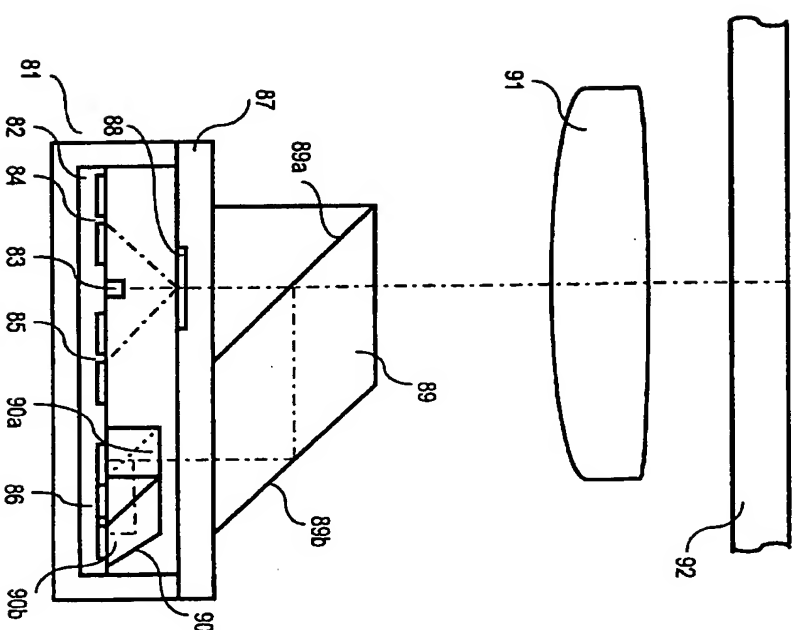


FIG. 11A
PRIOR ART

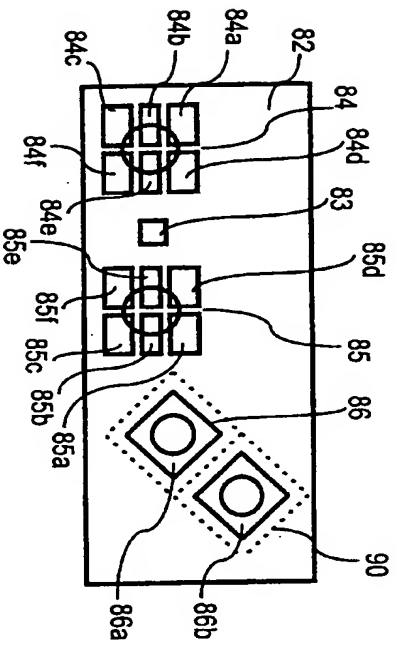


FIG. 11B
PRIOR ART

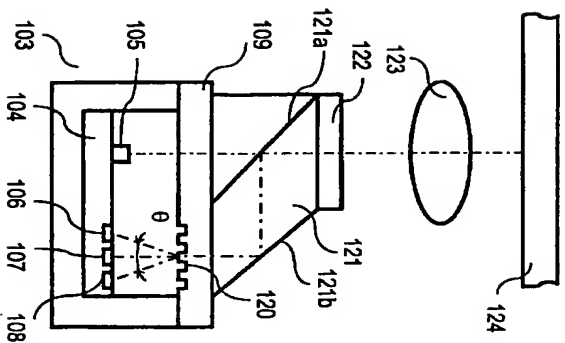


FIG. 12A PRIOR ART

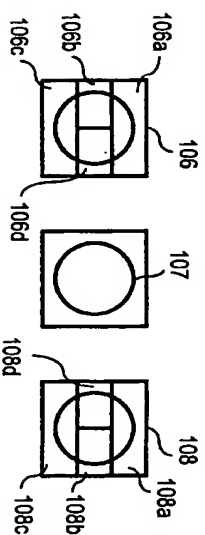


FIG. 12B PRIOR ART

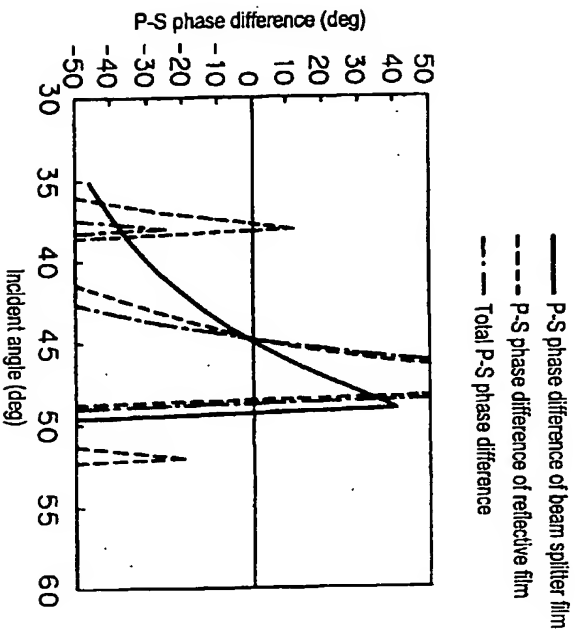


FIG. 13 PRIOR ART

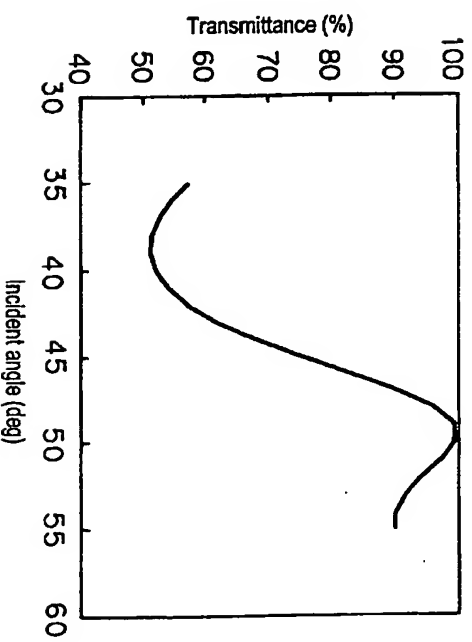


FIG. 14 PRIOR ART

COMPOSITE PRISM AND OPTICAL PICKUP USING THE SAME

FIELD OF THE INVENTION

The present invention relates to the field of prisms, and optical pickups employing prisms for integrating diffracted light.

BACKGROUND OF THE INVENTION

At present, magneto-optical disks, write-once optical disks, and compact disks (CDs) are already commercialized as optical disks for recording and reproducing information via irradiation of laser beams. There is, however, increasing interest in digital video disks (DVDs) as the next generation recording medium.

An optical pickup is a device for recording and reproducing information to and from optical disks. Increasing importance is now being placed on development of technology for miniaturization of optical pickups in response to the increasing trend towards integration.

One example of an optical pickup is Japanese Patent Application 47-134642, which discloses a small optical pickup for magneto-optical disks shown in FIGS. 11A and 11B. FIG. 11A is a simplified sectional view of an optical system of the above prior art. FIG. 11B is a top view of a light receiving element light emitting element, and analyzer. In FIGS. 11A and 11B a substrate 82 is provided inside an optical module 81. A laser diode 83 is the light emitting element and photo detectors 84, 85, and 86 as the light receiving elements are disposed on the substrate 82. The laser diode 83 has a structure which allows, for example, a concave portion having a 45° angled plane (not illustrated) to be disposed on one part of the substrate 82, and a light emitting chip (not illustrated) to be disposed inside that concave portion for reflecting light radiated from the light emitting chip on the 45° angled plane, thus emitting the beam upward. Each of the photo detectors 84 and 85 consists of six components: 84a to 84f and 85a to 85f, respectively. The photo analyzer 86 consists of two components 86a and 86b which are inclined approximately 45° with respect to the array direction of the photo detectors 84 and 85.

The transparent substrate 87 is made of glass or resin, and has a hologram diffraction grating 88 on the side facing the laser diode 83. The hologram diffraction grating 88 has a lens effect, giving different focal lengths to a primary diffraction light which have been diffracted between approximately 5° and 30°. The transparent substrate 87 is provided over the optical module 81 to seal the inside of the optical module 81. A polarizing prism 89 has a rectangular cross-section, formed by bonding a triangular prism having a right triangle cross-section and an approximate parallel plane having an approximately 45° cross section. A polarization beam splitter film consisting of multiple layers of a range of thin dielectric films is shown in Table 1 is applied to a bonded portion 89a of the crystal polarizer 89 in such a way, for example, that the transmittance of p-polarized light is approximately 70%, the reflectance of p-polarized light is approximately 30%, and the reflectance of s-polarized light is approximately 100% when p-polarized light is emitted from the laser diode 83.

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TABLE 1

Thin substrate	
n = 1.455	
Substrate	119 nm
1st layer	TO ₂
2nd layer	SO ₂
3rd layer	TO ₂
4th layer	SO ₂
5th layer	TO ₂
6th layer	SO ₂
7th layer	TO ₂
8th layer	SO ₂
9th layer	TO ₂
Substrate	119 nm
n = 1.455	

The polarizing prism 89 is integrated onto the transparent substrate 87, and an angled plane 89b inclines toward the inside of the optical module 81. A reflection film consisting of multiple layers of a range of thin dielectric film is shown in Table 2 is applied to the surface of the angled plane 89b.

TABLE 2

Thin substrate	
n = 1.455	
Substrate	119 nm
1st layer	TO ₂
2nd layer	SO ₂
3rd layer	TO ₂
4th layer	SO ₂
5th layer	TO ₂
6th layer	SO ₂
7th layer	TO ₂
8th layer	SO ₂
9th layer	TO ₂
10th layer	SO ₂
11th layer	TO ₂
12th layer	SO ₂
13th layer	TO ₂
14th layer	SO ₂
15th layer	TO ₂
16th layer	SO ₂
17th layer	TO ₂
18th layer	SO ₂
19th layer	TO ₂
20th layer	SO ₂
21st layer	TO ₂
22nd layer	SO ₂
23rd layer	TO ₂
24th layer	SO ₂
25th layer	TO ₂
26th layer	SO ₂
27th layer	TO ₂
28th layer	SO ₂
29th layer	TO ₂
30th layer	SO ₂
31st layer	TO ₂
32nd layer	SO ₂
33rd layer	TO ₂
34th layer	SO ₂
35th layer	TO ₂
36th layer	SO ₂
37th layer	TO ₂
38th layer	SO ₂
39th layer	TO ₂
40th layer	SO ₂
41st layer	TO ₂
42nd layer	SO ₂
43rd layer	TO ₂
44th layer	SO ₂
45th layer	TO ₂
46th layer	SO ₂
47th layer	TO ₂
48th layer	SO ₂
49th layer	TO ₂
50th layer	SO ₂
51st layer	TO ₂
52nd layer	SO ₂
53rd layer	TO ₂
54th layer	SO ₂
55th layer	TO ₂
56th layer	SO ₂
57th layer	TO ₂
58th layer	SO ₂
59th layer	TO ₂
60th layer	SO ₂
61st layer	TO ₂
62nd layer	SO ₂
63rd layer	TO ₂
64th layer	SO ₂
65th layer	TO ₂
66th layer	SO ₂
67th layer	TO ₂
68th layer	SO ₂
69th layer	TO ₂
70th layer	SO ₂
71st layer	TO ₂
72nd layer	SO ₂
73rd layer	TO ₂
74th layer	SO ₂
75th layer	TO ₂
76th layer	SO ₂
77th layer	TO ₂
78th layer	SO ₂
79th layer	TO ₂
80th layer	SO ₂
81st layer	TO ₂
82nd layer	SO ₂
83rd layer	TO ₂
84th layer	SO ₂
85th layer	TO ₂
86th layer	SO ₂
87th layer	TO ₂
88th layer	SO ₂
89th layer	TO ₂
90th layer	SO ₂
91st layer	TO ₂
92nd layer	SO ₂
93rd layer	TO ₂
94th layer	SO ₂
95th layer	TO ₂
96th layer	SO ₂
97th layer	TO ₂
98th layer	SO ₂
99th layer	TO ₂
100th layer	SO ₂
101st layer	TO ₂
102nd layer	SO ₂
103rd layer	TO ₂
104th layer	SO ₂
105th layer	TO ₂
106th layer	SO ₂
107th layer	TO ₂
108th layer	SO ₂
109th layer	TO ₂
110th layer	SO ₂
111th layer	TO ₂
112th layer	SO ₂
113th layer	TO ₂
114th layer	SO ₂
115th layer	TO ₂
116th layer	SO ₂
117th layer	TO ₂
118th layer	SO ₂
119th layer	TO ₂
120th layer	SO ₂
121st layer	TO ₂
122nd layer	SO ₂
123rd layer	TO ₂
124th layer	SO ₂
125th layer	TO ₂
126th layer	SO ₂
127th layer	TO ₂
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129th layer	TO ₂
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131st layer	TO ₂
132nd layer	SO ₂
133rd layer	TO ₂
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136th layer	SO ₂
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161st layer	TO ₂
162nd layer	SO ₂
163rd layer	TO ₂
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173rd layer	TO ₂
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180th layer	SO ₂
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182nd layer	SO ₂
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184th layer	SO ₂
185th layer	TO ₂
186th layer	SO ₂
187th layer	TO ₂
188th layer	SO ₂
189th layer	TO ₂
190th layer	SO ₂
191st layer	TO ₂
192nd layer	SO ₂
193rd layer	TO ₂
194th layer	SO ₂
195th layer	TO ₂
196th layer	SO ₂
197th layer	TO ₂
198th layer	SO ₂
199th layer	TO ₂
200th layer	SO ₂
201st layer	TO ₂
202nd layer	SO ₂
203rd layer	TO ₂
204th layer	SO ₂
205th layer	TO ₂
206th layer	SO ₂
207th layer	TO ₂
208th layer	SO ₂
209th layer	TO ₂
210th layer	SO ₂
211st layer	TO ₂
212nd layer	SO ₂
213rd layer	TO ₂
214th layer	SO ₂
215th layer	TO ₂
216th layer	SO ₂
217th layer	TO ₂
218th layer	SO ₂
219th layer	TO ₂
220th layer	SO ₂
221st layer	TO ₂
222nd layer	SO ₂
223rd layer	TO ₂
224th layer	SO ₂
225th layer	TO ₂
226th layer	SO ₂
227th layer	TO ₂
228th layer	SO ₂
229th layer	TO ₂
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253rd layer	TO ₂
254th layer	SO ₂
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256th layer	SO ₂
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259th layer	TO ₂
260th layer	SO ₂
261st layer	TO ₂
262nd layer	SO ₂
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322nd layer	SO ₂
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375th layer	TO ₂
376th layer	SO ₂
377th layer	TO ₂
378th layer	SO ₂
379th layer	TO ₂
380th layer	SO _{2</}

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the laser diode 105 and photo detectors 106, 107, and 108 into the optical module 100, and manufacturing costs have been reduced due to lack of need for extreme precision in the positioning of the photo detectors 106, 107, and 108.

Integration of components of optical pickups is achieved by employing a semiconductor laser which essentially generates diffused light, spreading to a certain range, as a light source. Therefore, the optical characteristics of components of optical pickups are strongly affected by the incident angle.

In the optical pickup for magneto-optical disks shown in FIGS. 11A and 11B, a phase difference may occur between the p-polarization light and s-polarization light responsive to broad incident angles because the polarization beam splitter film and reflection film disposed respectively on the face 89a of a glass material having an approximate parallelogram cross-section and the plane 89b which is approximately parallel to the plane 89a only consist of dielectric films.

FIG. 13 shows the phase difference between the p-polarized light and s-polarized light (hereafter referred to as the "p-s phase difference") of light reflected on the polarization beam splitter film, the p-phase difference of light reflected on the reflection film, and the total of the p-s phase difference of the polarization beam splitter film and of the reflection film. This explains the dependence of the p-s phase difference on the incident angle when the light is reflected on a disk surface. As shown in FIG. 13, the p-s phase difference of the polarization beam splitter film is -50° to $+40^\circ$ when the light incident angle is $\pm 10^\circ$ with respect to the prism, therefore $45^\circ \pm 50^\circ$ with respect to the optical film. The p-s phase difference of the reflection film exceeds -50° and the p-s phase difference of the light entering the photo detector (shown as the total p-s phase difference in FIG. 13) also exceeds -50° to $+50^\circ$.

To satisfactorily reproduce the information recorded on a magneto-optical disk, the p-s phase difference when the light enters the photo detector may require to be within -20° to $+20^\circ$. With the polarization beam splitter film and reflection film of the prior art, it may be difficult to design an optical pickup which achieves the above preferable range for diffused light.

In the optical pickup for DVDs as shown in FIGS. 12A and 12B, transmittance of the p-polarized light in the polarization beam splitter film greatly depends on the incident angle, as shown in FIG. 14, when the light enters at a wide incident angle (the incident angle to the optical film is $45^\circ \pm 7^\circ$ when the incident angle to the prism is $1^\circ \pm 6^\circ$). This may cause unsatisfactory reproduction due to reduced light entering the light receiving area.

Furthermore, since the hologram diffraction grating 120 is disposed on the transparent substrate 109 which seals the inside of the optical module, it may be necessary to broaden the diffraction angle 0 of the diffracted light, i.e. to narrow the pitch of the diffraction grating, when the distance between the hologram diffraction grating 120 and photo detectors 106, 107, and 108 is short. This may cause difficulties in manufacturing such diffraction gratings, resulting in failure to achieve a satisfactory optical pickup.

SUMMARY OF THE INVENTION

The present invention offers a magneto-optical pickup which reduces the p-s phase difference.

The present invention further offers an optical pickup for DVDs which improves the light efficiency during reproduction and permits a wider diffraction grating.

A prism of the present invention and an optical pickup for magneto-optical disks employing the prism of the present

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invention comprises an approximate parallel prism having a polarization beam splitter disposed on an angled plane of a glass material having an approximate parallelogram cross-section and a reflection film on an angled plane which is approximately parallel to the angled plane on which the polarization beam splitter is disposed in the same glass material. The polarization beam splitter consists of a multilayer film of a composite film made of a mixture of Si and SiO_2 (~ 40.5) (hereafter "semiprecipitate film") and multiple layers of multiple dielectric films. The reflection film consists of a multilayer film of a composite film made of a mixture of metal Si and oxide SiO_2 (~ 40.5) (hereafter "amorphous film") as high refractive film and multiple layers of multiple dielectric films as a relatively low refractive film.

In the approximate parallel prism of the magneto-optical pickup of the present invention, desirable reflective index n and absorption coefficient k of the composite film in the polarization beam splitter are $n \geq 2.8$ and $k \leq 0.3$.

In the approximate parallel prism of the optical pickup of the present invention, desirable diffraction index n and absorption coefficient k of the composite film in the reflection film are $n \geq 2.8$ and $k \leq 0.3$.

To achieve the aforementioned effect in an optical pickup for DVDs, the prism and optical pickup of the present invention comprises a parallel prism having a polarization beam splitter disposed on an angled plane of a glass material having an approximate parallelogram cross-section, a hologram diffraction grating disposed on an angled plane which is approximately parallel to an angled plane on which the polarization beam splitter is disposed, and a reflection film on the hologram diffraction grating. The polarization beam splitter consists of a multilayer film of a composite film made of Si and SiO_2 (~ 40.5) and multiple layers of multiple dielectric films. The reflection film consists of a single metal film or multilayer film of a metal film and dielectric film.

In the approximate parallel prism of the optical pickup of the present invention, desirable reflective index n and absorption coefficient k of the composite film in the polarization beam splitter are $n \geq 2.8$ and $k \leq 0.3$.

The reflection film is preferably made of an Ag film. It is more preferable to form a patterned reflection film by precision processing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a prism in accordance with a first exemplary embodiment of the present invention.

FIG. 2 shows the dependence on the incident angle of the p-s phase difference of a polarization beam splitter film in accordance with the first exemplary embodiment of the present invention.

FIG. 3 shows the dependence on the incident angle of the p-s phase difference of a reflection film in accordance with the first exemplary embodiment of the present invention. FIG. 4 shows the dependence on the incident angle of the p-s phase difference of the light passing through the polarization beam splitter film and the reflection film in accordance with the first exemplary embodiment of the present invention.

FIG. 5 is a sectional view of an optical pickup in accordance with a second exemplary embodiment of the present invention.

FIG. 6 is a sectional view of a prism in accordance with a third exemplary embodiment of the present invention.

FIG. 7 shows the dependence on the incident angle of the transmittance of the prism in accordance with the third exemplary embodiment of the present invention.

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FIG. 8 is a sectional view of an optical pickup in accordance with a fourth exemplary embodiment of the present invention.

FIG. 9 is a sectional view of a prism of an optical pickup in accordance with a fifth exemplary embodiment of the present invention.

FIG. 10 is a sectional view of an optical pickup in accordance with a sixth exemplary embodiment of the present invention.

FIG. 11A is a simplified sectional view of an optical system of the prior art.

FIG. 11B is a top view of FIG. 11A illustrating a light receiving element, light emitting element, and photo detector of the prior art.

FIG. 12A is a simplified sectional view of an optical system of the prior art.

FIG. 12B is a top view of FIG. 12A illustrating a light receiving element, light emitting element, and photo detector of the prior art.

FIG. 13 shows the dependence on the incident angle of the p-s phase difference of a prism of the prior art.

FIG. 14 shows the dependence on the incident angle of the transmittance of a polarization beam splitter film of the prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention employs a parallel prism comprising a polarization beam splitter film on an angled plane of a glass material having an approximate parallelogram cross-section and a reflection film disposed on an angled plane approximately parallel to the angled plane on which the polarization beam splitter film is disposed. The polarization beam splitter film consists of a multilayer film of a composite film made of a mixture of Si and SiO_2 (~ 40.5) and multiple layers of multiple dielectric films. The reflection film consists of a multilayer film of a composite film made of a mixture of Si and SiO_2 (~ 40.5) as a high refractive film and multiple layers of multiple dielectric films as a relatively low refractive film. Changes in optical characteristics can be prevented although the light incident angle changes, by employing a composite film of a mixture of Si and SiO_2 (~ 40.5) in the polarization beam splitter film and reflection film. In other words, the composite film of the present invention has high refractive index n and low absorption coefficient k for reducing the dependence on the incident angle.

The refractive index n and absorption coefficient k of the composite film in the polarization beam splitter of the optical pickup of the present invention are $n \geq 2.8$ and $k \leq 0.3$. The refractive index n and absorption coefficient k of the composite film in the reflection film are also $n \geq 2.8$ and $k \leq 0.3$. The above values of the refractive index and absorption coefficients assure that the dependence on the incident angle is reduced and efficiency is improved.

The present invention according to one embodiment employs a parallel prism comprising a polarization beam splitter film disposed on an angled plane of a glass material having an approximate parallelogram cross-section, a hologram diffraction grating disposed on an angled plane in the same glass material approximately parallel to the angled plane on which the polarization beam splitter is disposed, and a reflection film disposed on the hologram diffraction grating. The polarization beam splitter film consists of a multilayer film of a composite film made of a mixture of Si

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and SiO_2 (~ 40.5) and multiple layers of multiple dielectric films. The reflection film consists of a single metal film or a multilayer film of a metal film and dielectric film.

Changes in optical characteristics can be prevented, although the light incident angle changes, by employing the composite film made of a mixture of Si and SiO_2 (~ 40.5) in the polarization beam splitter film. In other words, the composite film of the present invention has high refractive index n and low absorption coefficient k for reducing the dependence on the incident angle. Since the hologram grating is disposed on the parallel prism, the optical distance between the hologram grating and the photo detector can be made longer, enabling the reduction of the diffraction angle θ of the hologram diffraction grating. This allows broader pitch of the hologram pattern for facilitating the creation of hologram grating in production.

The present invention according to another embodiment is an optical pickup in which the metal film in the polarization beam splitter has the refractive index n of $n \geq 2.8$ and the absorption coefficient k of $k \leq 0.3$. The dependence on the incident angle and efficiency can be improved by limiting the refractive index n and absorption coefficient k to the above ranges.

In one aspect of the present invention the metal film in the reflection film is made of Ag. The use of Ag for the metal film of the reflection film reduces the dependence of the reflectance on the incident angle and improves reflectance.

The present invention according to still another embodiment is an optical pickup comprising a patterned reflection film at least on the hologram diffraction grating by providing the reflection film only on the hologram diffraction grating. Pitting of the reflection film can be thus suppressed and satisfactory optical pickup can be realized although the reflection film and glass material show poor adhesion.

The present invention according to another embodiment employs a parallel prism comprising a polarization beam splitter disposed on an angled plane of a parallelogram glass material having an approximate 45° cross-section and a hologram diffraction grating disposed on an angled plane approximately parallel to the angled plane on which the polarization beam splitter is disposed in the same glass material. The polarization beam splitter film consists of a multilayer film of a composite film made of a mixture of Si and SiO_2 (~ 40.5) and multiple layers of multiple dielectric films. The refractive index n of the glass material is $n \geq 1.6$. A small optical pickup with higher efficiency and smaller dependence on the incident angle can be achieved without using a reflection film for adjusting the reflectance of the hologram diffraction grating.

According to one aspect of the above embodiment, the present invention is an optical pickup in which the refractive index n , absorption coefficient k , and total thickness d of the metal film in the polarization beam splitter is set to $n \geq 2.8$ and $k \leq 0.3$. The dependence on the incident angle and efficiency can be improved by limiting the refractive index n and absorption coefficient k to the above ranges.

The exemplary embodiments of the present invention are explained with reference to FIGS. 1 to 10 next.

FIG. 1 shows a sectional view of a prism employed in an optical pickup for magneto-optical disks in a first exemplary embodiment of the present invention. FIGS. 2 to 6 show the dependence on the incident angle of the p-s phase difference of the prism.

As shown in FIG. 1, a prism 1 comprises a parallelogram-shaped glass material 2 having an approximate 45° cross-

angled plane 53 in the same glass material 51. A reflection film 56 made of Ag is disposed on the hologram diffraction grating 55.

Triangular prisms 57 and 58 are disposed on both sides of the glass material 51, and they are respectively bonded through the polarization beam splitter film 53 and the reflection film 56.

FIG. 7 shows changes of the transmittance of the polarized light according to the light incident angle of the polarization beam splitter film 53 comprising a multi-layer film of the present invention. The transmittance of the polarization beam splitter film 53 is 79% to 50% (incident angle: 45° to 77°). It is apparent that the transmittance is stabilized at small transmittance compared to that of the prior art, as shown in FIG. 14, which is 50% to 100%.

In FIG. 7, the light incident angle is plotted along the abscissa, and this is the angle created between the normal angled plane 53 of the polarization beam splitter film 53 and the entering light.

As for the composite film in the polarization beam splitter film and reflection film consisting of a mixture of Si and SiO_2 , " $n=0.27$ " is used as an example. The same characteristics can be achieved as long as n is $0.4<n<0.5$.

Stabilized transmittance for the P-polarized light regardless of the incident angle can be achieved because a multi-layer film of a dielectric film and metal film basically compensates mutual characteristics, as already explained in the first exemplary embodiment. In addition, high refractive index n and low absorption coefficient k can be achieved by employing a composite film consisting of a mixture of Si and SiO_2 instead of a single metal film.

The refractive index and absorption coefficient k of the composite film in the polarization beam splitter film, consisting of a mixture of Si and SiO_2 , affect the dependence of the P-s phase difference of the reflected light on the incident angle as shown in FIG. 7. A larger refractive index n and smaller absorption coefficient k for a composite film are preferred, and to be more specific, $n=2.8$, $k=0.3$ are desirable.

Since the hologram diffraction grating 55 is disposed on the angled plane 54 which is approximately parallel to the angled plane 53 of the glass material 51, the optical distance between the hologram optical element and the photo detector can be made longer than that in the prior art shown in FIGS. 11A and 11B, enabling the reduction of the diffraction angle θ of the hologram diffraction grating 55. This allows broader pitch of the hologram pattern for facilitating the creation of hologram grating in production.

Furthermore, the dependence of reflectance on the incident angle can be reduced and high reflectance can be achieved by using Ag for the metal film of the reflection film. By providing a patterned reflection film at least on the hologram diffraction grating 55, peeling of the reflection film can be suppressed and desirable optical pickup can be achieved, in spite of poor adhesivity of the reflection film to the glass material.

This exemplary embodiment employs a parallel-shaped glass material 51 having an approximate 45° cross-section. However, the transmittance of P-polarized light depending on the incident angle can be stabilized compared to the representative parallel prism using a multi-layer film of the prior art, as long as the angle is between 35° to 55° by disposing the multi-layer film 53 on the angled plane 54, the hologram diffraction grating 55 on the angled plane 54 approximately parallel to the angled plane 54, and the reflection film 56 on the hologram diffraction grating 55.

Fourth Exemplary Embodiment

FIG. 8 shows a simplified sectional view of an optical system of an optical pickup in a fourth exemplary embodiment of the present invention employing a prism in accordance with the third exemplary embodiment of the present invention. In this exemplary embodiment, a prism in the third exemplary embodiment is mounted on the transparent substrate 109 without the hologram diffraction grating 120 of the optical pickup shown in FIGS. 12A and 12B. At measuring the characteristics for reproduction of DVDs employing the optical pickup of this exemplary embodiment, desirable reproduction has been achieved due to the increase in light efficiency by stabilizing the P-polarized light transmittance against the incident angle compared to the optical pickup of the prior art.

Fifth Exemplary Embodiment

FIG. 9 shows a sectional view of a parallel prism having an approximate 45° cross-section, employed in a pickup for DVDs in a fifth exemplary embodiment of the present invention.

As shown in FIG. 9, a prism 70 comprises a glass material 71 having an approximate parallelogram cross-section and a glass material 76 having an approximate triangular cross-section. The refractive index n of the glass material 71 having an approximate parallelogram cross-section is 1.4. A polarization beam splitter film 73 comprising a multi-layer film of a composite film made of Si and SiO_2 ($n=0.27$), and multiple layers of multiple dielectric films such as Al_2O_3 , SiO_2 , Y_2O_3 , and TiO_2 , films shown in Table 8 and Table 9, is disposed on an angled plane 72 of the glass material 71. The polarization beam splitter film 73 shown in Tables 8 and 9 consists of a 20-layer film.

A hologram diffraction grating 75 is disposed on an angled plane 74 approximately parallel to the angled plane 72 in the same glass material 71.

Triangular prism 76 is disposed on the side of the polarization beam splitter film 73 on the glass material 71, and is bonded through the polarization beam splitter film 73. The effect of employing the multi-layer film for the polarization beam splitter film 73 in this exemplary embodiment is the same as that in the second exemplary embodiment, and thus the explanation for the effect is omitted here.

As for the composite film in the polarization beam splitter film and reflection film consisting of a mixture of Si and SiO_2 , " $n=0.27$ " is used as an example. The same characteristics can be achieved as long as n is $0.4<n<0.5$.

The refractive index n and absorption coefficient k of the composite film in the polarization beam splitter film 73, consisting of a mixture of Si and SiO_2 , affect the dependence of the P-s phase difference of the reflected light on the incident angle as shown in FIG. 7. A larger refractive index n and smaller absorption coefficient k for a composite film are preferred, and to be more specific, $n=2.8$, $k=0.3$ are desirable, as explained in the third exemplary embodiment. Since the hologram grating is disposed on the angled plane 74 which is approximately parallel to the angled plane 72 of the glass material 71, the optical distance between the hologram grating 75 and the photo detector can be made longer than that in the prior art shown in FIGS. 12A and 12B, enabling the reduction of the diffraction angle θ of the hologram grating. This allows broader pitch of the hologram pattern for facilitating the creation of hologram grating in production. This is also the case as the third exemplary embodiment.

The fifth exemplary embodiment may not require the reflection film 56 and triangular prism 58 which are

employed in the third exemplary embodiment because the angle of the glass material 71 is approximately 45° and its refractive index is 1.6 in this exemplary embodiment for achieving desirable reflection characteristics for reflection on the glass material 71/air surface. Desirable reflection characteristics can be achieved when the refractive index n of the glass material 71 is $n=1.6$.

Sixth Exemplary Embodiment

FIG. 10 shows a simplified sectional view of the optical system of the optical pickup in a sixth exemplary embodiment employing a prism of the fifth exemplary embodiment of the present invention. In this exemplary embodiment, the prism in the fifth exemplary embodiment is mounted on the transparent substrate 109 without the hologram grating 120 of the optical pickup shown in FIGS. 12A and 12B. At measuring the characteristics for reproduction of DVDs employing the optical pickup of this exemplary embodiment, desirable reproduction has been achieved due to the increase in light efficiency by stabilizing the P-polarized light transmittance against the incident angle, compared to the optical pickup of the prior art.

As described above, the prism and the optical pickup employing such prism of the present invention greatly reduces the P-s phase difference and achieves desirable reproduction without increasing the dependence of the reflectance and transmittance on the incident angle. Since the hologram grating is disposed on the parallel plane in the prism of the present invention and the optical pickup employing such prism, the optical distance between the hologram optical element and the photo detector can be made longer than that in the prior art, enabling the reduction of the diffraction angle θ of the hologram diffraction grating. This allows broader pitch of the hologram pattern for facilitating the creation of hologram grating in production. Furthermore, the dependence of reflectance on the incident angle can be reduced and high reflectance can be achieved by using Ag for the metal film of the reflection film. By also providing a patterned reflection film at least on the hologram diffraction grating, peeling of the reflection film can be suppressed and desirable optical pickup can be achieved, in spite of poor adhesivity of the reflection film to the glass material.

Desirable reflection characteristics for reflection on the glass material 71/air surface can also be achieved by employing a parallel prism having an approximate 45° cross-section and setting the refractive index n to 1.6 or above. What is claimed is:

1. A prism for optical pickups, comprising:
 - a glass material having an approximate parallelogram cross-section and having a first angled plane and a second angled plane approximately parallel to each other;
 - a multi-layer film disposed on said first angled plane of the glass material, said multi-layer film comprising a composite film comprising a mixture of Si and SiO_2 , wherein $n=0.5$, and multiple layers of multiple dielectric films; and
 - a multi-layer film disposed on said second angled plane of the glass material, said multi-layer film comprising a composite film comprising a mixture of Si and SiO_2 , wherein $n=0.5$, and multiple layers of multiple dielectric films; and
2. A prism for optical pickups as defined in claim 1, further comprising:
 - a first triangular prism bonded to said multi-layer film formed on said first angled plane of the glass material;

a second triangular prism bonded to said multi-layer film formed on said second angled plane of the glass material.

3. A prism for optical pickups as defined in claim 1, wherein said dielectric films include at least one of Al_2O_3 , SiO_2 , Y_2O_3 , and TiO_2 .

4. A prism for optical pickups as defined in claim 1, wherein said composite film disposed on said first angled plane of the glass material has a refractive index $n=2.8$ and an absorption coefficient $k=0.3$, and said composite film disposed on said second angled plane of the glass material has a refractive index $n=2.8$ and an absorption coefficient $k=0.3$.

5. An optical pickup comprising the prism of claim 1, wherein said multi-layer film disposed on said first angled plane of the glass material is a polarization beam splitter and said multi-layer film disposed on said second angled plane of the glass material is a reflection film.

6. An optical pickup as defined in claim 5, wherein the refractive index n and absorption coefficient k of the composite film in a polarization beam splitter are $n=2.8$ and $k=0.3$, and the refractive index n and absorption coefficient k of the composite film reflection film are $n=2.8$ and $k=0.3$.

7. A prism for optical pickups, comprising:

- a glass material having an approximate parallelogram cross-section and having a first angled plane and a second angled plane approximately parallel to each other; and
- a hologram diffraction grating disposed on said second angled plane;

a multi-layer film disposed on said first angled plane of the glass material, said multi-layer film comprising a composite film comprising a mixture of Si and SiO_2 , wherein $n=0.5$ and multiple layers of multiple dielectric films; and

a multi-layer film disposed on said hologram diffraction grating on said second angled plane of the glass material, said multi-layer film comprising at least one of Al_2O_3 , SiO_2 , Y_2O_3 , and TiO_2 .

8. A prism for optical pickups as defined in claim 7, further comprising:

- a first triangular prism bonded to said multi-layer film formed on said first angled plane of the glass material;
- a second triangular prism bonded to said multi-layer film formed on said second angled plane of the glass material;

9. A prism for optical pickups as defined in claim 7, wherein said dielectric films include at least one of Al_2O_3 , SiO_2 , Y_2O_3 , and TiO_2 .

10. A prism for optical pickups as defined in claim 7, wherein the refractive index n and absorption coefficient k of the composite film disposed on said first angled plane of the glass material are $n=2.8$ and $k=0.3$, and the refractive index n and absorption coefficient k of the film formed on said second angled plane of the glass material are $n=2.8$ and $k=0.3$.

11. An optical pickup, comprising:

a glass material having an approximate parallelogram cross-section and having a first angled plane and a second angled plane approximately parallel to each other; and a hologram diffraction grating disposed on said second angled plane;

a multi-layer film disposed on said first angled plane of the glass material, said multi-layer film comprising a composite film comprising a mixture of Si and SiO_2 , wherein $n=0.5$, and multiple layers of multiple dielectric films; and

a multi-layer film disposed on said hologram diffraction grating on said second angled plane of the glass material, said multi-layer film comprising at least one;

wherein said multi-layer film disposed on said first angled plane of the glass material is a polarization beam splitter and said multi-layer film disposed on said second angled plane of the glass material is a reflection film;

12. An optical pickup employing a parallel prism, comprising:

a multi-layer film disposed on an angled plane of a glass material having an approximate parallelogram cross-section, said multi-layer film being a polarization beam splitter and comprising a composite film comprising a mixture of Si and SiO_2 , wherein $x \leq 0.5$, and multiple layers of multiple dielectric films;

a hologram diffraction grating disposed on an angled plane of the same glass material approximately parallel to the angled plane on which said polarized beam splitter is disposed; and

a multi-layer film disposed on said hologram diffraction grating, said multi-layer film comprising one of a single metal film and multi-layer metal and dielectric film.

13. An optical pickup as defined in claim 12, wherein the refractive index n and absorption coefficient k of the metal film in the polarization beam splitter are $n \geq 2.8$ and $k \leq 0.3$.

14. An optical pickup as defined in claim 12, wherein the single metal film is an Ag reflection film.

15. An optical pickup as defined in claim 14, wherein the reflection film is patterned and at least disposed on said hologram diffraction grating.

16. A prism for optical pickups, comprising:

a glass material having an approximate parallelogram cross-section and having a first angled plane and a second angled plane approximately parallel to each other, and a hologram diffraction grating disposed on said second angled plane;

a multi-layer film disposed on said first angled plane of the glass material, said multi-layer film comprising a composite film comprising a mixture of Si and SiO_2 , wherein $x \leq 0.5$, and multiple layers of multiple dielectric films; and

an Ag film disposed on said hologram diffraction grating on said second angled plane of the glass material.

17. A prism for optical pickups as defined in claim 16, further comprising a first triangular prism bonded to said multi-layer film disposed on said first angled plane of the glass material.

18. A prism for optical pickups as defined in claim 16, wherein said dielectric films include at least one of Al_2O_3 , SiO_2 , Y_2O_3 , and TiO_2 .

19. A prism for optical pickups as defined in claim 16, wherein said composite film disposed on said first angled plane of the glass material has a refractive index $n \geq 2.8$ and an absorption coefficient $k \leq 0.3$.

20. An optical pickup, comprising:

a glass material having an approximate parallelogram cross-section and having a first angled plane and a second angled plane approximately parallel to each other, and a hologram diffraction grating disposed on said second angled plane;

a multi-layer film disposed on said first angled plane of the glass material, said multi-layer film comprising a composite film comprising a mixture of Si and SiO_2 , wherein $x \leq 0.5$, and multiple layers of multiple dielectric films; and

an Ag film disposed on said hologram diffraction grating on said second angled plane of the glass material.

wherein said multi-layer film disposed on said first angled plane of the glass material is a polarization beam splitter, and said Ag film disposed on said second angled plane of the glass material is a reflection film.

21. An optical pickup as defined in 20, wherein the refractive index n and absorption coefficient k of the metal film in the polarization beam splitter are $n \geq 2.8$ and $k \leq 0.3$.

22. An optical pickup employing a parallel prism, comprising:

a multi-layer film disposed on an angled plane of a parallelogram-shaped glass material having an approximate 45° cross-section, said multi-layer film being a polarization beam splitter and comprising a composite film comprising a mixture of Si and SiO_2 , wherein $x \leq 0.5$, and multiple layers of multiple dielectric films; and

a hologram diffraction grating disposed on an angled plane of the same glass material approximately parallel to the angled plane on which said polarized beam splitter is disposed,

wherein the refractive index of the glass material is $n \geq 1.6$.

23. An optical pickup as defined in claim 22, wherein the refractive index n and absorption coefficient k of a metal film in the polarization beam splitter are $n \geq 2.8$ and $k \leq 0.3$.

* * * * *

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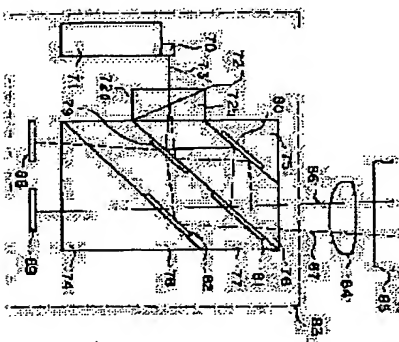
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(54) MULTIBEAM GENERATING METHOD AND MULTIBEAM OPTICAL PICKUP

(57) Abstract

PROBLEM TO BE SOLVED: To provide a small multibeam optical pickup at low cost capable of generating plural beams from a semiconductor laser having one light emitting point and simultaneously reproducing plural tracks.

SOLUTION: This optical pickup is composed of a semiconductor laser 70 having one light emitting point, a parallel plane plate wedge member 72 oppositely joining wedge-like birefringent members to each other, a laminated prism 74 integrally forming plural parallel plane plates, having a grating in one part of the joined surface, a polarizing beam splitter 82 in the other part of the joined surface and plural photodetectors and they are formed in one package. Consequently, the parts from the semiconductor laser to the photodetectors are integrally built-up and a multibeam generating method and a small multibeam optical pickup at low cost are obtained.



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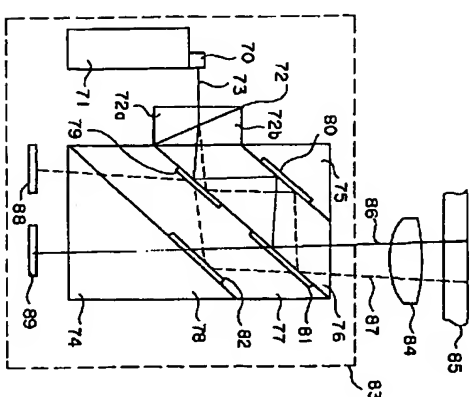
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(54) [発明の名称] ワルチビーム生成方法及びワルチビーム光ビシクアツツ

(57) [要約]

[課題] 一つの発光点を有する半導体レーザから複数のビームを生成し、複数のトラックを同時に再生することのできる小型で低コストなワルチビーム光ビシクアツツを提供することを目的とする。

[解決手段] 本発明の光ビシクアツツは、一つの発光点を有する半導体レーザ70と、くさび状の複屈折部材を互いに逆向きに接合した平行平板くさび部材72と、複数の平行平板を一体に成型し、その接合面の一部にグラレーインツとその接合面他の一部に偏光ビームスプリッタ82とを有するラミレートプリズム74と、複数の受光素子とを一つのパッケージに形成して構成した。よって、半導体レーザから受光素子までを一体に組み込むことができ、小型で低コストのワルチビーム生成方法及びワルチビーム光ビシクアツツが得られる。



【特許請求の範囲】

【請求項1】1つの発光点から出射した1本のレーザ光を、くさび状の複屈折部材を互いに逆向きに接合した平行平板くさび部材に透過させるスラブ状と、複数の平行平板が一体に成型されたラミレートプリズム部材であって、その接合面の一部に設けられたグレーティングを反射するスラブ状と、その接合面の一部に設けられた偏光ビームスプリッタを透過、または反射するスラブ状と、前記偏光ビームスプリッタを透過したビームと、前記偏光ビームスプリッタを反射したビームとを互いに別々の受光素子に受光するスラブ状とを有し、前記1本のレーザ光を前記平行平板くさび部材により2本のビームに分割し、さらに前記グレーティングにより2本のビームをそれぞれ3分割し合計6本のビームとして前記ラミレートプリズム部材より出射させ、被検出面から反射した入射光をその偏光面に応じて前記偏光ビームスプリッタにより3本ずつ2つのグループに分離して前記受光素子により受光することを特徴とするマルチビーム生成方法。

【請求項2】1つの発光点を有するレーザ光源と、くさび状の複屈折部材を互いに逆向きに接合した平行平板くさび部材と、複数の平行平板を一体に成型し、その接合面の一部にグレーティングと、その接合面他の一部に偏光ビームスプリッタとを有するラミレートプリズム部材と、複数の受光素子とを有し、前記レーザ光源の1本のビームを前記平行平板くさび部材により2本のビームに分割し、さらに前記グレーティングにより2本のビームをそれぞれ3分割し合計6本のビームとして前記ラミレートプリズム部材より出射させ、被検出面から反射した入射光をその偏光面に応じて前記偏光ビームスプリッタにより3本ずつ2つのグループに分離して前記受光素子により受光することを特徴とするマルチビーム光ビツクアツク。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、光学的情報記録媒体（光ディスク）上の情報を再生する装置は新しい構造をしている。また、コンピュータで取り扱うデータも、コンピュータから音楽、静止画像、動画と連関するにつれ、データ量も増大している。それに伴って、光ディスクの情報再生装置からホストコンピュータにデータを転送するスピードの高速化が要求されている。データ転送レートを高速度化するために、従来は光ディスクの回転数を上げる手法がもっぱら行われていた。

【0002】

【従来の技術】近年、レーザ光により光学的情報記録媒体（光ディスク）上の情報を再生する装置は新しい構造をしている。また、コンピュータで取り扱うデータも、コンピュータから音楽、静止画像、動画と連関するにつれ、データ量も増大している。それに伴って、光ディスクの情報再生装置からホストコンピュータにデータを転送するスピードの高速化が要求されている。データ転送レートを高速度化するために、従来は光ディスクの回転数を上げる手法がもっぱら行われていた。

【0003】しかしながらこの方法では、光ディスクを

回転駆動するモータの回転数を大幅に上げるためにモータを大型化しなければならないとか回転数の上昇に伴って光ディスクの振動や面歪れが大きくなりサーボ系の安定化が困難になる等の問題が生じている。

【0004】そこで、情報の読み取りを行う光ビツクアツクで複数のレーザビームを発生させ、光ディスクに対して複数のトラッキングから同時に情報の再生を行うマルチビーム光ビツクアツクが提案されている。この方法は、モータを大型化する必要もなく、さらに回転数の上昇に伴うディスクの振動や面歪れも押さえることが可能であるため、有望視されている。

【0005】以下、図に基づいて従来のマルチビーム光ビツクアツクの技術の説明をする。図3は従来のマルチビーム光ビツクアツクの構成図である。図において、半導体レーザ40には2個のレーザチップ41、42があり、2本のビームを発生している。これらの2本のビームはコリメートレンズ2により平行光となり、グレーティング3により3ビーム化され合計6本のビームがハーフトラミエー8を通り、対物レンズ9により集光され光ディスク10に照射される。光ディスク10からの反射光は、再び対物レンズ9を通りハーフトラミエー8で反射され、検出レンズ43、シリンドリカルレンズ44を通り、受光素子45に入射する。フォーカス検出は公知の非点収差法により、トラツク検出は公知の3ビーム法により行われる。

【0006】図4は光ディスク上のトラツクとスポットとの関係を示した図である。3ビーム法のメインスポット27、及び30はトラツク32、33の中央に位置し、サイドスポット26、29はトラツク33、32の右に、サイドスポット28、31はトラツク33、32の左に、それぞれ位置している。

【0007】情報の再生はメインスポット27、30によって行われる。フォーカス検出はメインスポット27により、トラツク検出はサイドスポット26、28により行われる。また、半導体レーザ40の2個のレーザチップ41、42の間隔は150μmであり、光ディスク上のメインスポット27、30の間隔は光学系の倍倍率が約1/5なので30μmになる。メインスポット27とサイドスポット28との間隔は約10μmである。そして、メインスポット27、30の存在により光ディスクの2つのトラツクから同時に情報を再生することが可能である。

【0008】しかしながら、光ディスクの偏心によりトラツクが傾斜を起すこと、メインスポットの一方はトラッキングサーボ制御により常にトラツク中心に位置するが、他方のメインスポットはトラツクずれを引き起こし再生信号が低下するという問題がある。

【0009】図5は光ディスクの偏心によるスポット位置ずれの説明図である。図5において、光ディスクに偏心が無い時がトラツク32、33であり、2つのメイン

スポット36、37は各々トラツク32、33（実線表示）の中心に位置している。しかし、光ディスクに偏心がある時にはトラツク34、35（点線表示）にずれた位置にあり、一方のメインスポット38はトラッキングサーボ制御により常にトラツク34の中心に位置するが、もう一方のメインスポット39はトラツク35よりオフトラツクした位置にある。このため、メインスポット39により情報を再生すると信号が低下する。

【0010】この偏心の問題を解消するためにマルチビームのメインスポット相互の間隔を定める方法が提案された。図6はメインスポット相互の間隔を定めた従来のトラツクとスポットとの配置図である。図6において、メインスポット27、30の間隔を定め、3ビーム法のメインスポット27、30とサイドスポット26、28、29、31との間隔よりマルチビームのメインスポット27、30相互の間隔を定める方法が考えられる。図の所では、メインスポット27とサイドスポット26、28とが1つのレーザ光源からの光であり、メインスポット30とサイドスポット29、31とが他方のレーザ光源からの光である。メインスポット27、30の相互間隔は光ディスク10の偏心による再生信号の低下が十分無視できる5μmに設定されている。

【0011】図7は図6のマルチビームの受光素子21、24、46とスポット26〜31との関係を示す図である。図において、非点収差法によるフォーカス信号を検出するための4分割受光素子46、3ビーム法によるトラツク信号を検出するための2つの受光素子21、22が一枚の基板上に配置されている。

【0012】しかしながら、スポットの相互間隔が狭いため受光素子21、22上に2つのレーザチップ41、42を光源とするサイドスポット（26と29及び28と31）が照射されているため、フォーカス信号、トラツク信号、再生信号が正確に検出できない問題が生じる。さらに、半導体レーザ40に2個のレーザチップ41、42を搭載して2本のビームを発生させる方法はコストが安いという問題がある。そこで、一つの半導体レーザと複屈折材料からなるくさび部材からマルチビームを生成し、偏光ビームスプリッタによりマルチビームを分離して受光素子に入射させることにより前述のレーザチップの問題を解決する方法が提案されている。

【0013】図8はくさび部材を使った従来のマルチビーム光ビツクアツクの構成図である。図8において、半導体レーザ40から一本のレーザビームが発生している。このビームはコリメートレンズ2により平行光となり、グレーティング3により3本のビーム41に変換され、複屈折くさび部材5により常光線7（点線表示）と異常光線6（実線表示）に分離され合計6本のビームになる。

【0014】複屈折くさび部材5の材質には水晶が使用される。その水晶の変長780nmの常光線7に対して

屈折率は1.5387384、異常光線6に対する屈折率は1.5476658である。半導体レーザ40からビームの偏光面を45度回転させて複屈折くさび部材5に入射させると、複屈折くさび部材5の中でレーザ光は常光線7と異常光線6とに分かれて進行し、常光線7に対する屈折率と異常光線6とに対する屈折率が異なるため、複屈折くさび部材5から出射する際に2つの光線に分離されて異なる方向に出射することになる。例えば、くさびの頂角を10度と設定すると分離される2つのビームのなす角度は0.90度になり、対物レンズ9の焦点距離を5mmとすると2つのスポットの間隔は4.7μmになる。このスポット間隔であれば、図6に示したように、光ディスク10の偏心による再生信号の低下を十分無視する事ができる。

【0015】複屈折くさび部材5から2つの光線に分離され合計6本のビームとして出射した後、ハーフトラミエー8で反射し対物レンズ9で集光されて光ディスク10のスポットに焦点を結ぶ。

【0016】光ディスク10からの反射光は、再び対物レンズ9を通りハーフトラミエー8を通過し、検出レンズ11を通り、偏光ビームスプリッタ12により、その入射光線の偏光面に応じて常光線7は反射され異常光線6は透過し受光素子13に入射する。フォーカス検出は常光線15と異常光線14とのスポットサイズ法により行われ、トラツク検出は公知の3ビーム法により行われる。

【0017】前述の図6において、3ビーム法のメインスポット27、及び30はトラツク32、33の中央に位置し、サイドスポット26、29はトラツクの右に、サイドスポット28、31はトラツクの左に位置している。情報の再生はメインスポット27、30によって行われる。フォーカス検出はメインスポット27により、トラツク検出はサイドスポット26、28により行われる。

【0018】図9は受光素子13上のスポットの配置を示した図である。異常光線14を検出する受光素子は20、21、22であり、常光線15を検出する受光素子は23、24、25である。受光素子20と受光素子23はそれぞれ3分割され、20-A、20-B、20-C、及び23-A、23-B、23-Cより構成される。メインスポット27、30の各々の集光点は受光素子13の前後にあるため、フォーカス信号を（20-A）+（20-C）-（20-B）-（23-A）+（23-C）-（23-B）により得ることができる。

【0019】またトラツク信号は、21-22により得られる。

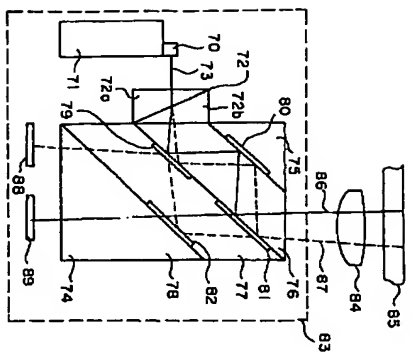
【0020】

【発明が解決しようとする課題】しかしながら、以上に説明した各従来の方法は、半導体レーザの光をコリメートレンズにより平行光に変換してから対物レンズに入射

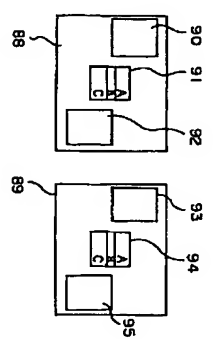
- 9
- 72 平行平板くさび部材
- 72a 第1の平行平板くさび部材
- 72b 第2の平行平板くさび部材
- 73 レーザビーム
- 74 ラミネートガラス
- 75、76、77、78 平行平板

- 79 全反射コーティング
- 80 グレーティング
- 81 ビームスプリッタコーティング
- 88、89 基板
- 91、94 3分割受光素子

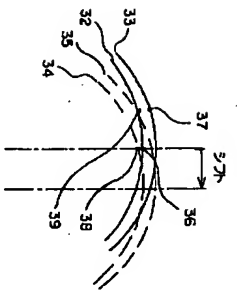
【図1】



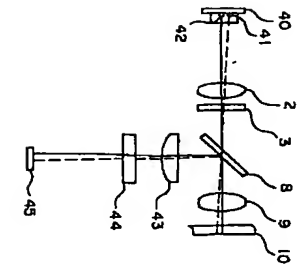
【図2】



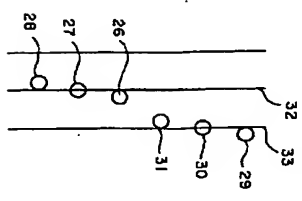
【図5】



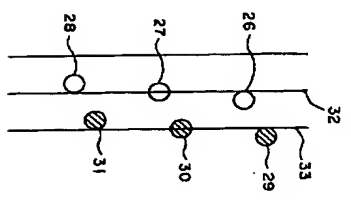
【図3】



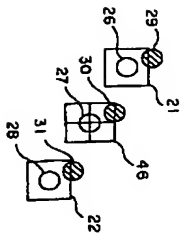
【図4】



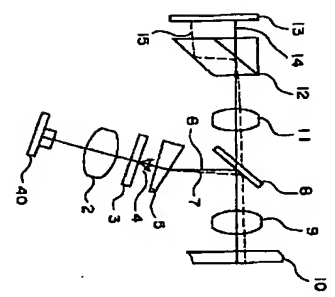
【図6】



【図7】



【図8】



【図9】

